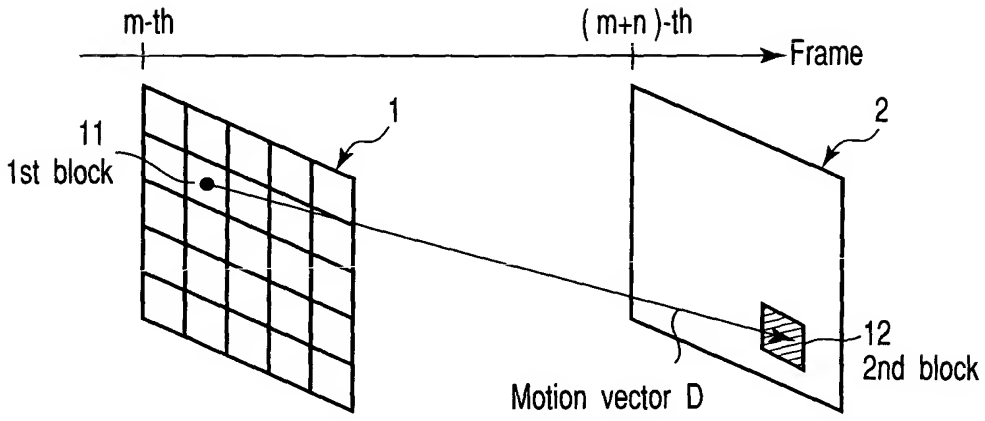

m-th
(m+n)-th
Frame
11
1st block
1
2
12
2nd block
Motion vector D

FIG. 1

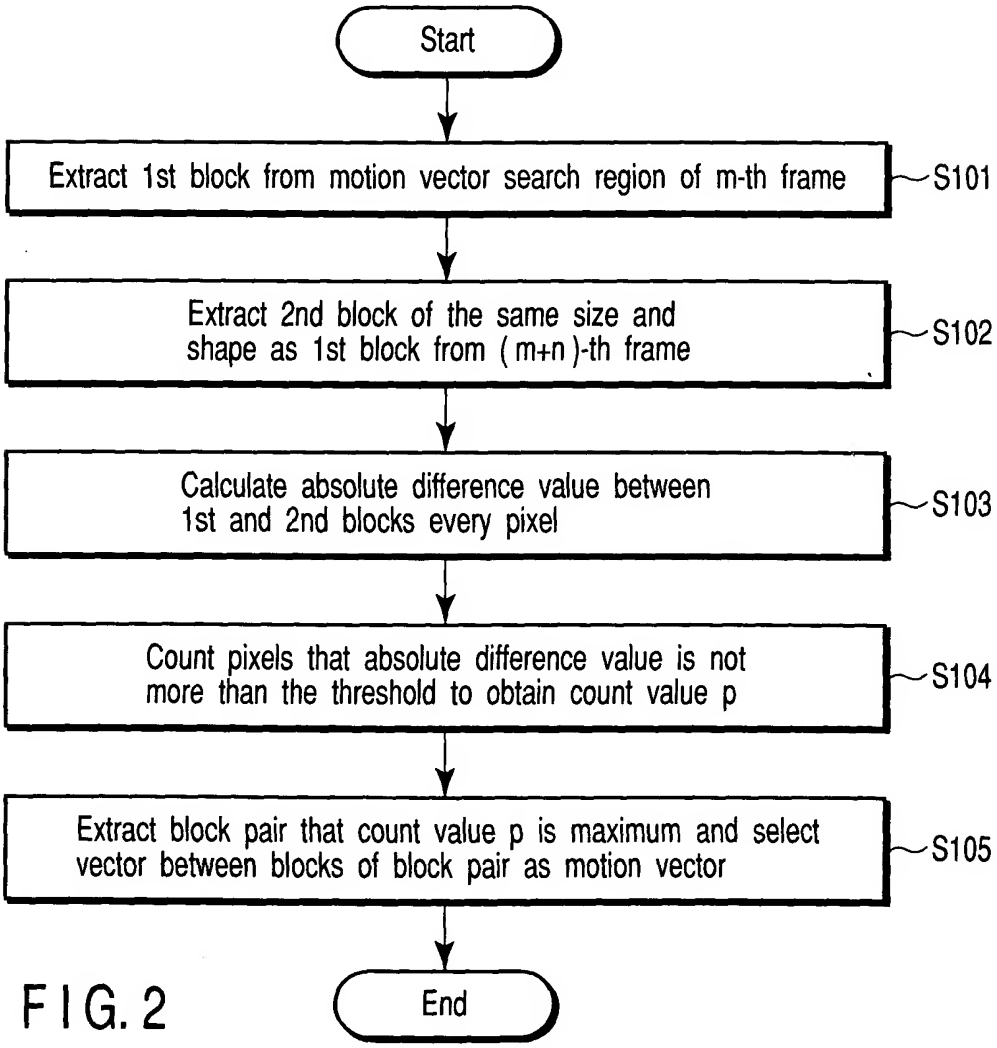

Start
Extract 1st block from motion vector search region of m-th frame
S101
Extract 2nd block of the same size and shape as 1st block from (m+n)-th frame
S102
Calculate absolute difference value between 1st and 2nd blocks every pixel
S103
Count pixels that absolute difference value is not more than the threshold to obtain count value p
S104
Extract block pair that count value p is maximum and select vector between blocks of block pair as motion vector
S105
End

FIG. 2

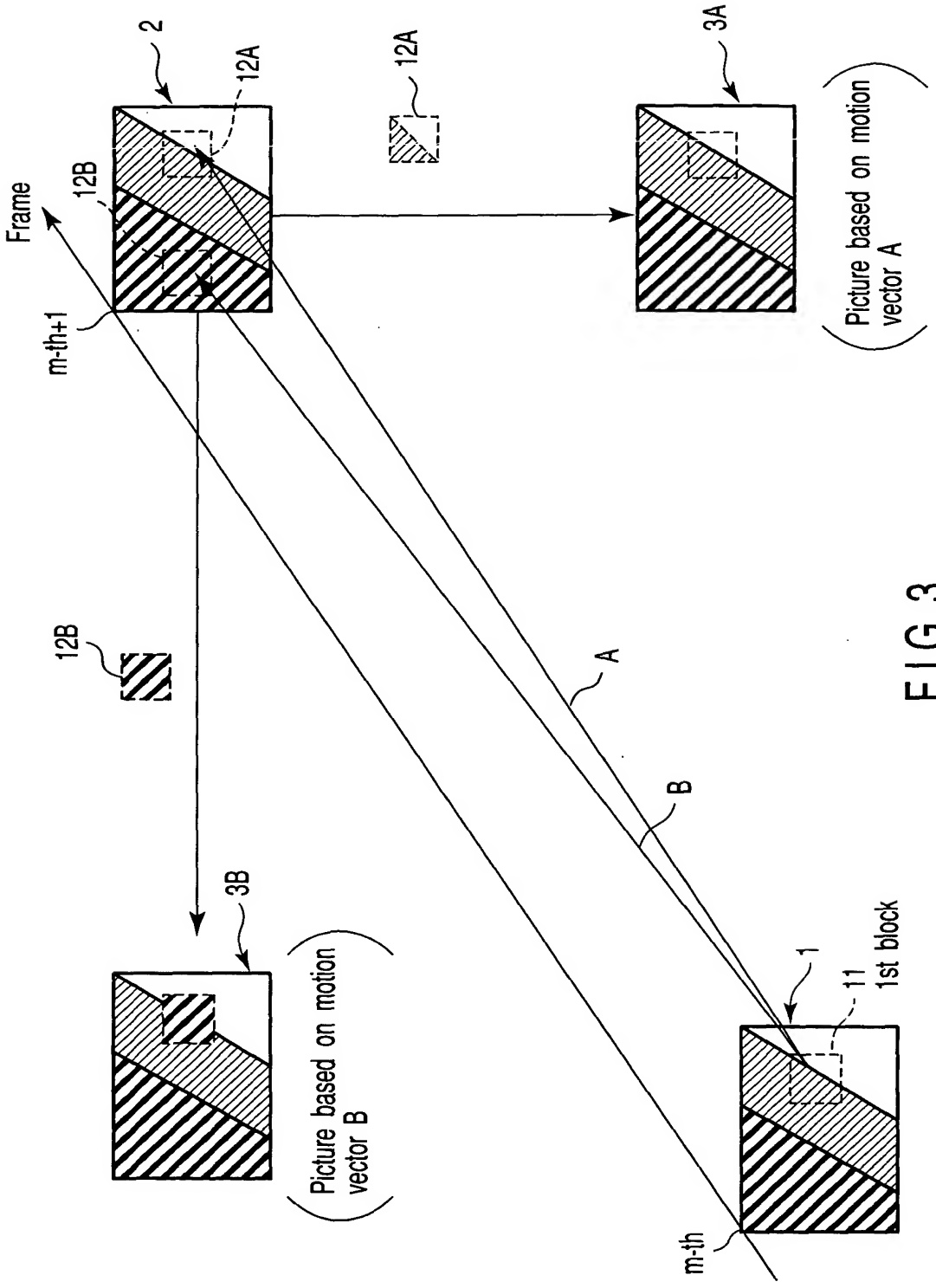

2
12A
12A
3A
Frame
12B
m-th+1
Picture based on motion vector A
12B
A
B
3B
Picture based on motion vector B
1
11
1st block
m-th

FIG. 3

100	100	60
100	60	60
60	60	60

FIG. 4A

120	120	80
120	80	80
80	80	80

FIG. 4B

70	70	70
70	70	70
70	70	70

FIG. 4C

20	20	20
20	20	20
20	20	20

Sum of absolute differences = 180

FIG. 4D

30	30	10
30	10	10
10	10	10

Sum of absolute differences = 150

FIG. 4E

100	100	60
100	60	60
60	60	60

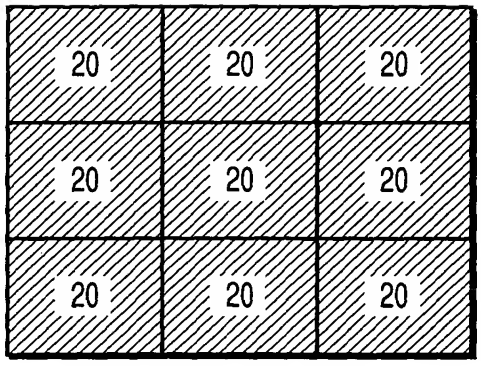
FIG. 5A

120	120	80
120	80	80
80	80	80

FIG. 5B

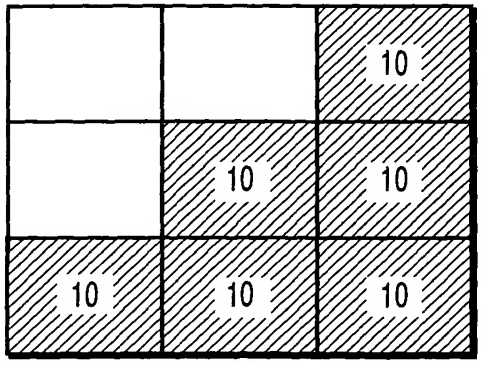
70	70	70
70	70	70
70	70	70

FIG. 5C



The number of pixels not more than threshold = 9

FIG. 5D



The number of pixels not more than threshold = 6

FIG. 5E

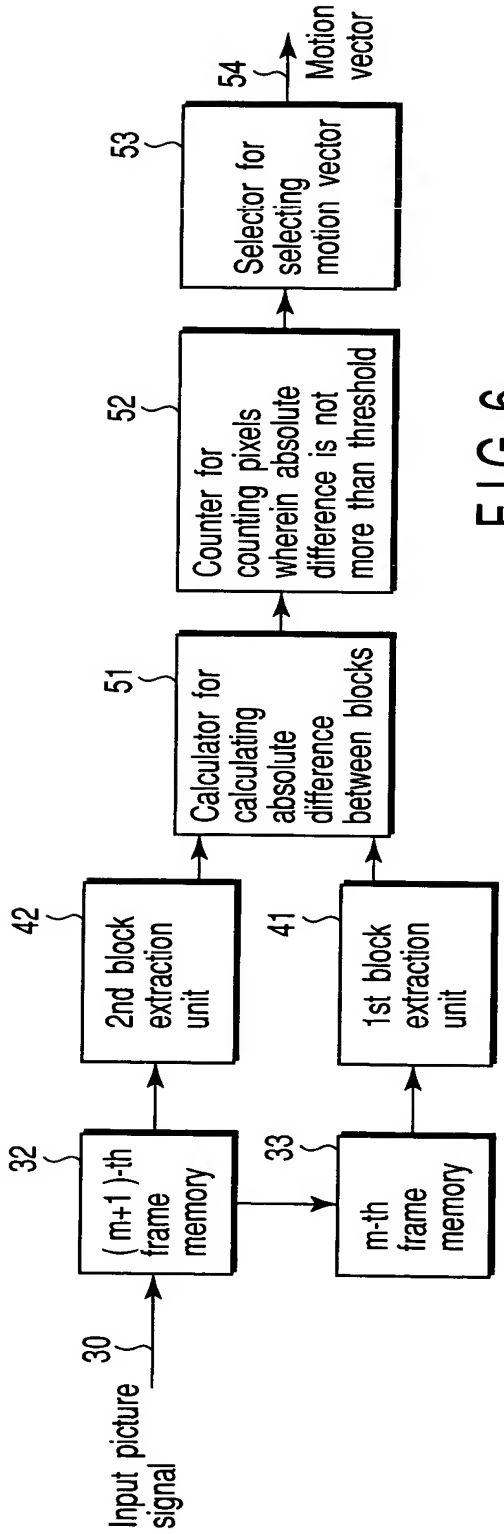

Input picture signal
30
(m+1)-th frame memory
32
m-th frame memory
33
2nd block extraction unit
42
1st block extraction unit
41
Calculator for calculating absolute difference between blocks
51
Counter for counting pixels wherein absolute difference is not more than threshold
52
Selector for selecting motion vector
53
54
Motion vector

FIG. 6

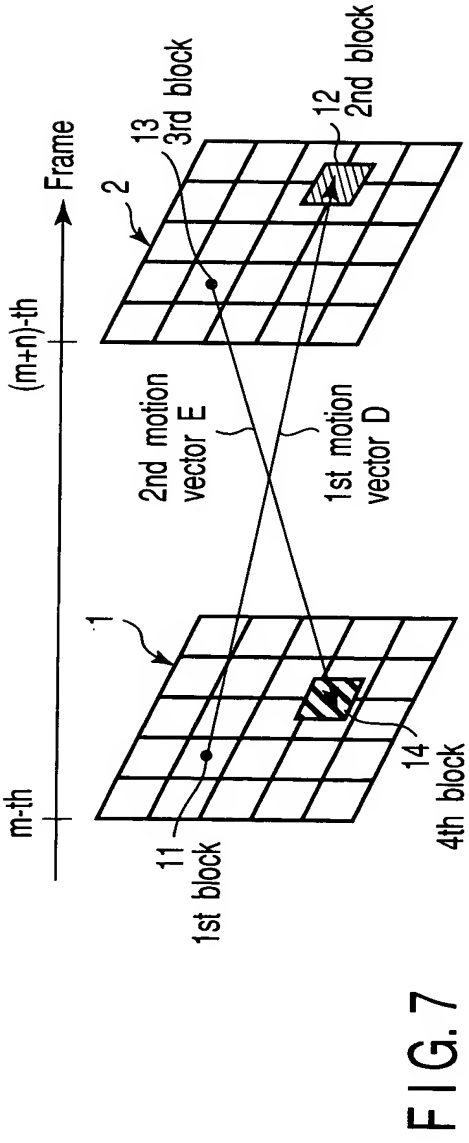

Frame
(m+n)-th
m-th
1
2
11
1st block
12
2nd block
13
3rd block
14
4th block
2nd motion vector E
1st motion vector D

FIG. 7

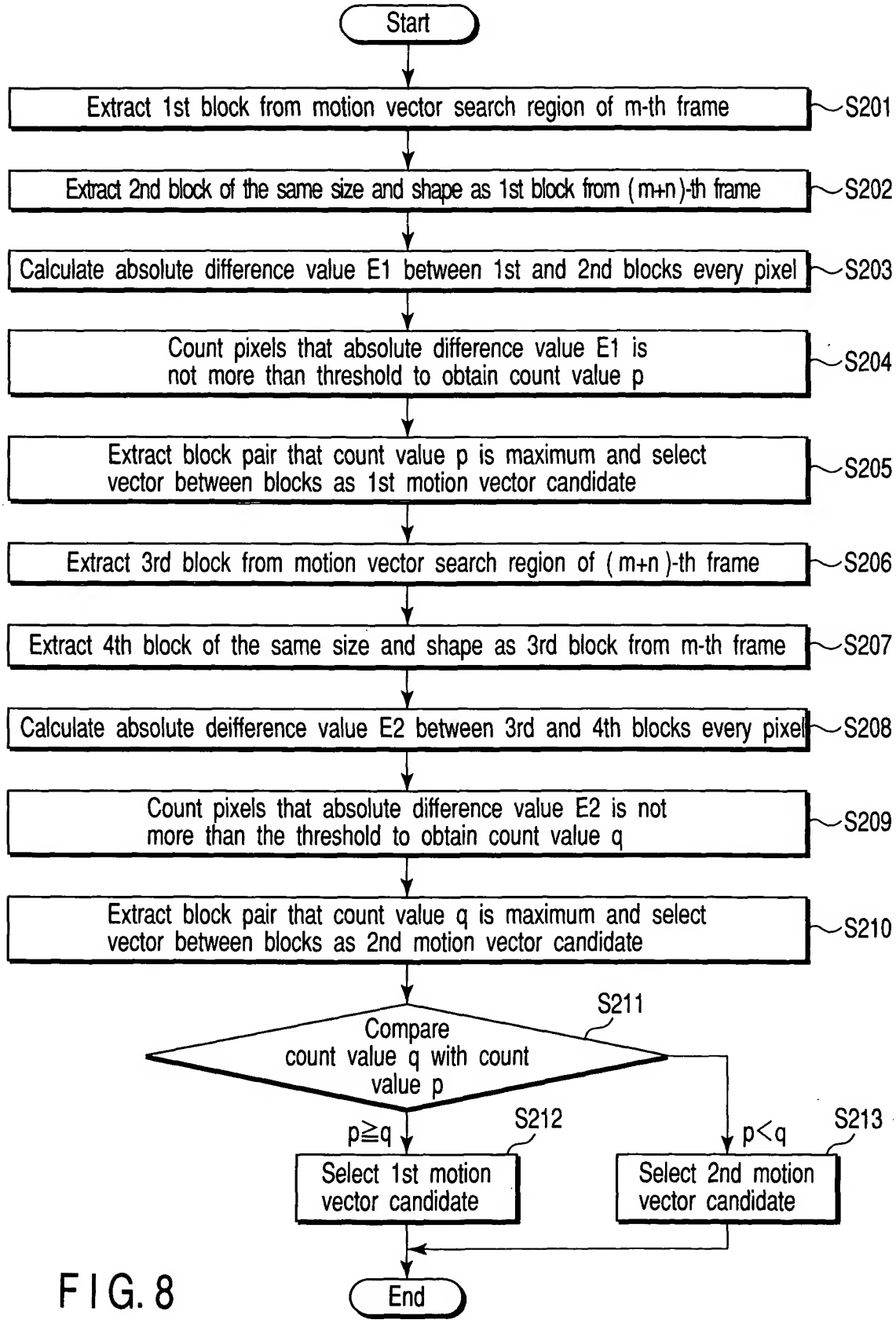

Start
Extract 1st block from motion vector search region of m-th frame
S201
Extract 2nd block of the same size and shape as 1st block from (m+n)-th frame
S202
Calculate absolute difference value E1 between 1st and 2nd blocks every pixel
S203
Count pixels that absolute difference value E1 is not more than threshold to obtain count value p
S204
Extract block pair that count value p is maximum and select vector between blocks as 1st motion vector candidate
S205
Extract 3rd block from motion vector search region of (m+n)-th frame
S206
Extract 4th block of the same size and shape as 3rd block from m-th frame
S207
Calculate absolute deifference value E2 between 3rd and 4th blocks every pixel
S208
Count pixels that absolute difference value E2 is not more than the threshold to obtain count value q
S209
Extract block pair that count value q is maximum and select vector between blocks as 2nd motion vector candidate
S210
S211
Compare count value q with count value p
p≧q
S212
Select 1st motion vector candidate
p<q
S213
Select 2nd motion vector candidate
End

FIG. 8

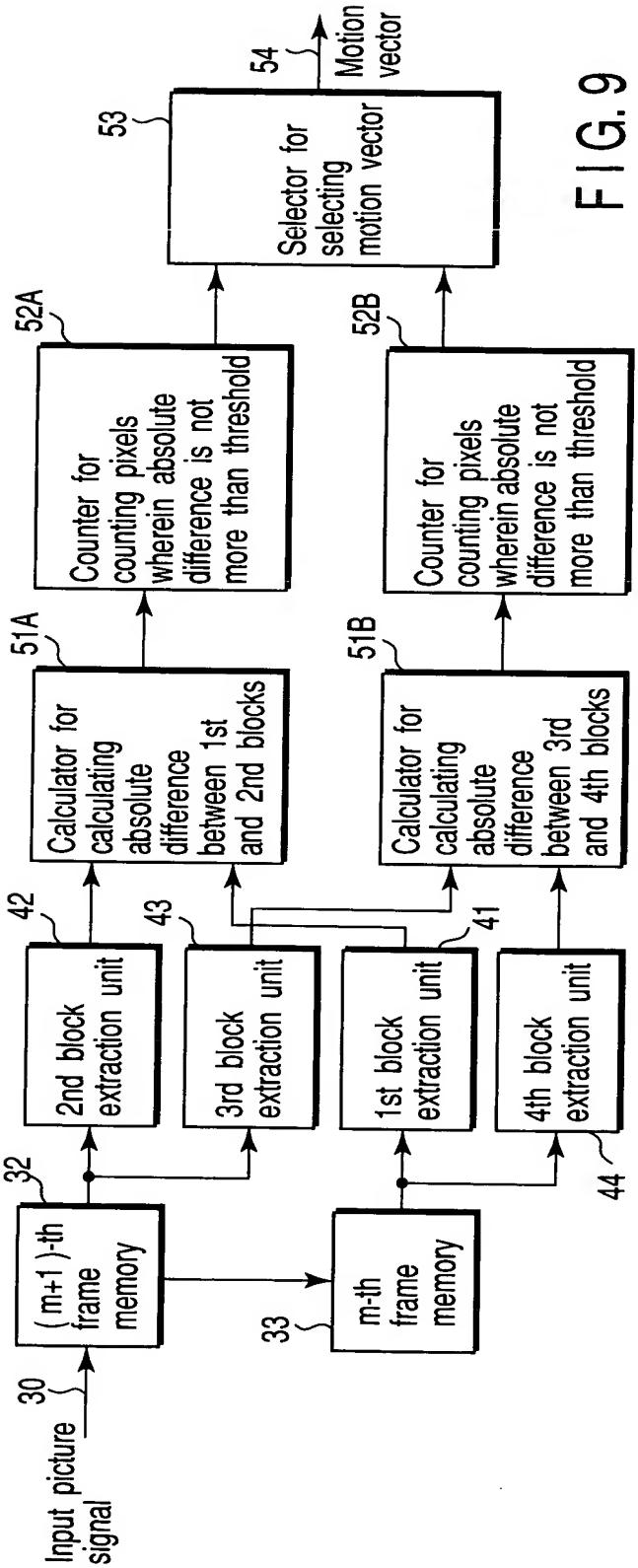

Input picture signal
30
(m+1)-th frame memory
32
m-th frame memory
33
2nd block extraction unit
42
3rd block extraction unit
43
1st block extraction unit
41
4th block extraction unit
44
Calculator for calculating absolute difference between 1st and 2nd blocks
51A
Calculator for calculating absolute difference between 3rd and 4th blocks
51B
Counter for counting pixels wherein absolute difference is not more than threshold
52A
Counter for counting pixels wherein absolute difference is not more than threshold
52B
Selector for selecting motion vector
53
54
Motion vector

FIG. 9

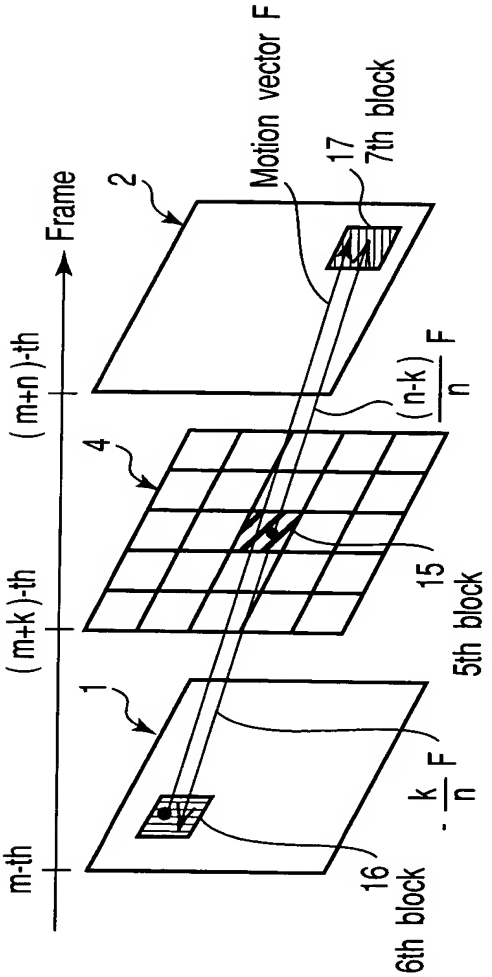

Frame
m-th
(m+k)-th
(m+n)-th
1
2
4
Motion vector F
17
7th block
15
5th block
16
6th block
$-\frac{k}{n}F$
$\frac{(n-k)}{n}F$

FIG. 10

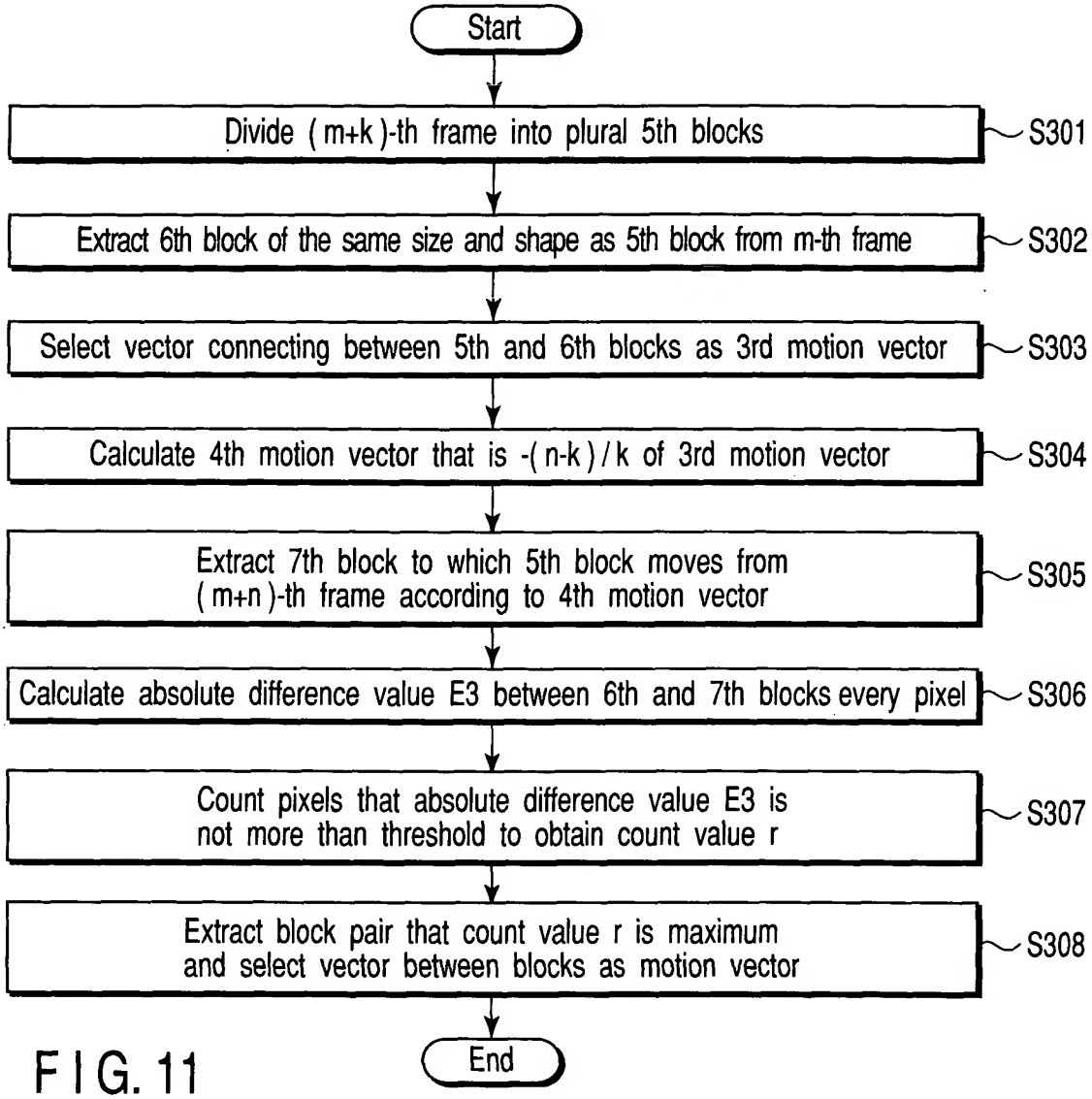

Start
Divide (m+k)-th frame into plural 5th blocks
S301
Extract 6th block of the same size and shape as 5th block from m-th frame
S302
Select vector connecting between 5th and 6th blocks as 3rd motion vector
S303
Calculate 4th motion vector that is -(n-k) / k of 3rd motion vector
S304
Extract 7th block to which 5th block moves from (m+n)-th frame according to 4th motion vector
S305
Calculate absolute difference value E3 between 6th and 7th blocks every pixel
S306
Count pixels that absolute difference value E3 is not more than threshold to obtain count value r
S307
Extract block pair that count value r is maximum and select vector between blocks as motion vector
S308
End

FIG. 11

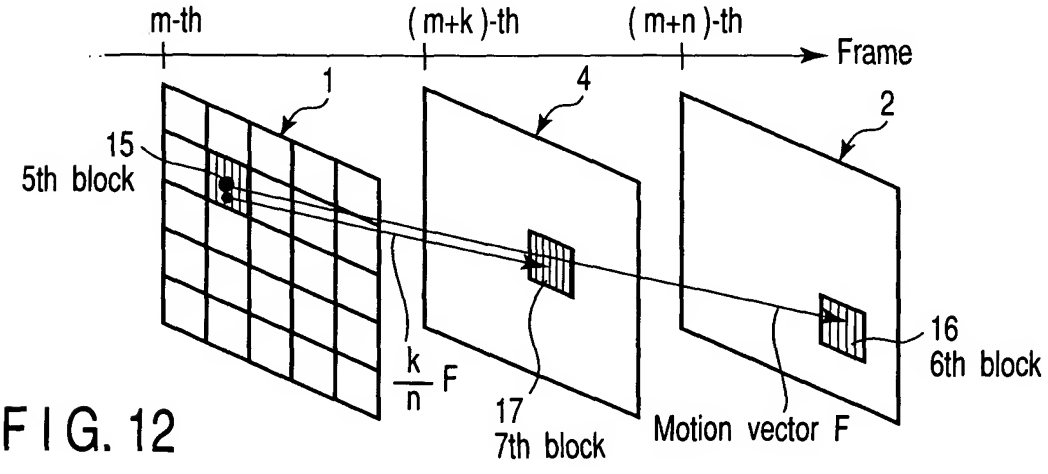

m-th
(m+k)-th
(m+n)-th
Frame
1
4
2
15
5th block
k/n F
17
7th block
Motion vector F
16
6th block

FIG. 12

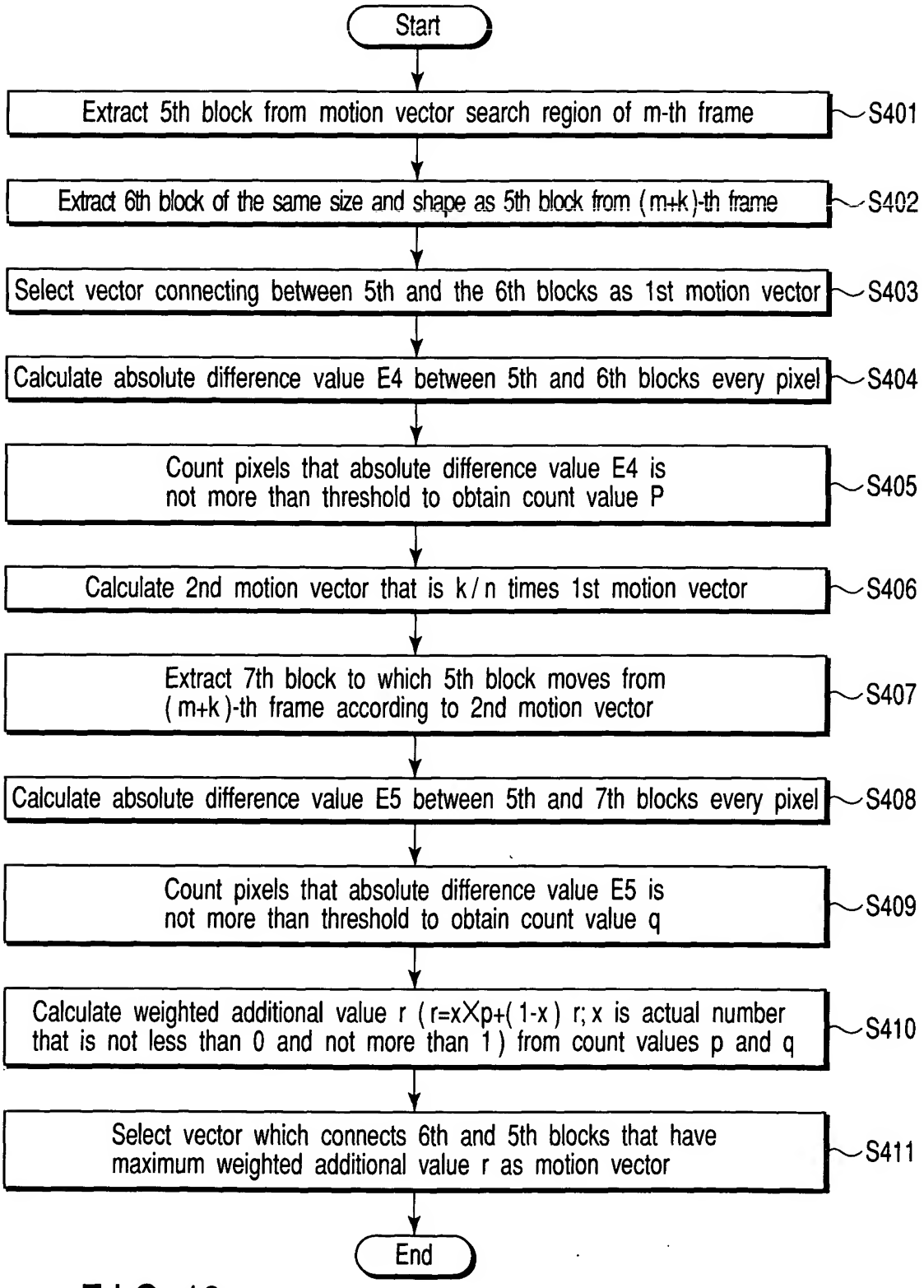

Start
Extract 5th block from motion vector search region of m-th frame
S401
Extract 6th block of the same size and shape as 5th block from (m+k)-th frame
S402
Select vector connecting between 5th and the 6th blocks as 1st motion vector
S403
Calculate absolute difference value E4 between 5th and 6th blocks every pixel
S404
Count pixels that absolute difference value E4 is not more than threshold to obtain count value P
S405
Calculate 2nd motion vector that is k/n times 1st motion vector
S406
Extract 7th block to which 5th block moves from (m+k)-th frame according to 2nd motion vector
S407
Calculate absolute difference value E5 between 5th and 7th blocks every pixel
S408
Count pixels that absolute difference value E5 is not more than threshold to obtain count value q
S409
Calculate weighted additional value r (r=xXp+(1-x) r; x is actual number that is not less than 0 and not more than 1) from count values p and q
S410
Select vector which connects 6th and 5th blocks that have maximum weighted additional value r as motion vector
S411
End

FIG. 13

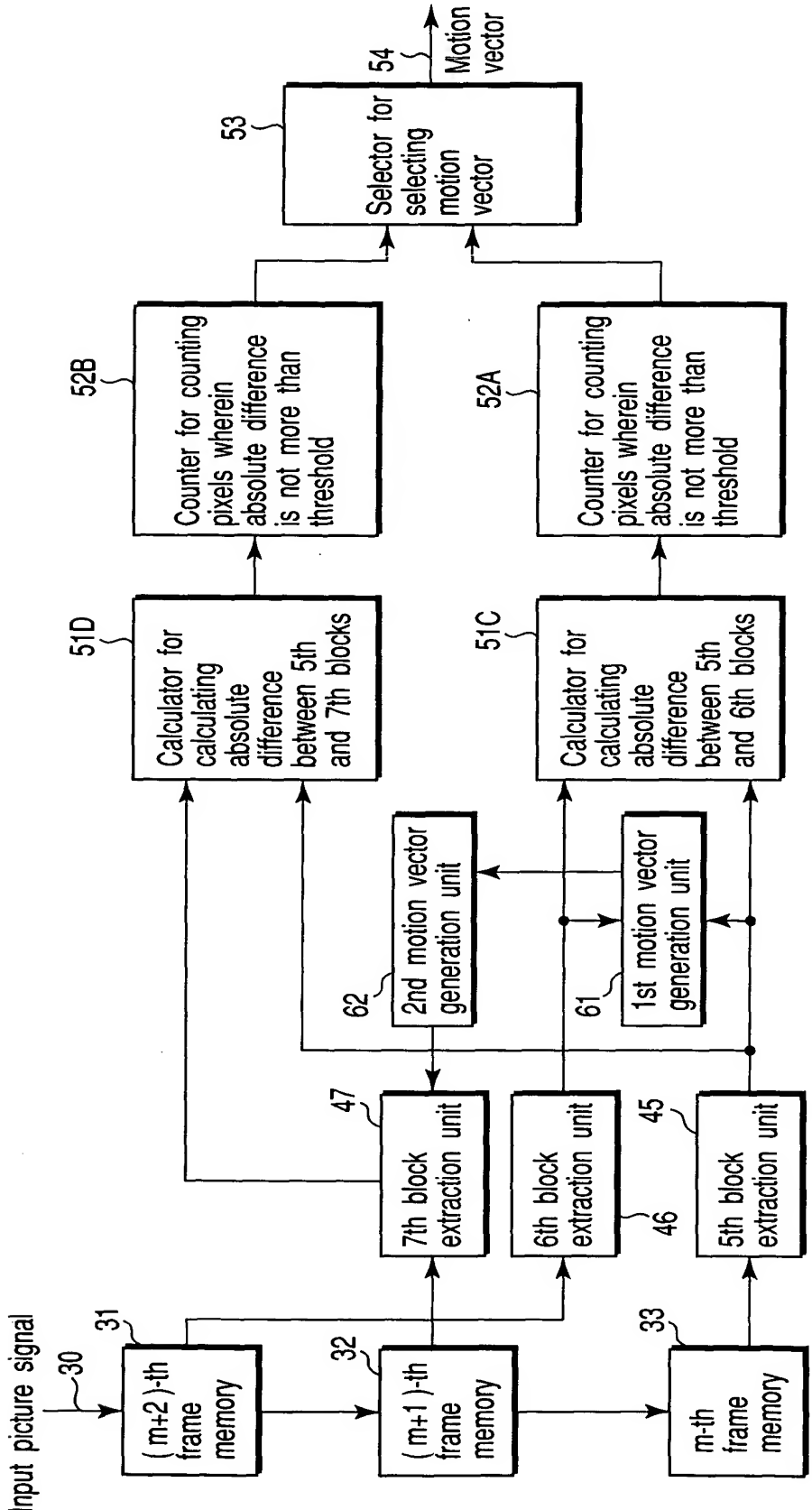

Input picture signal
30
31
(m+2)-th frame memory
32
(m+1)-th frame memory
33
m-th frame memory
47
7th block extraction unit
46
6th block extraction unit
45
5th block extraction unit
62
2nd motion vector generation unit
61
1st motion vector generation unit
51D
Calculator for calculating absolute difference between 5th and 7th blocks
51C
Calculator for calculating absolute difference between 5th and 6th blocks
52B
Counter for counting pixels wherein absolute difference is not more than threshold
52A
Counter for counting pixels wherein absolute difference is not more than threshold
53
Selector for selecting motion vector
54
Motion vector

FIG. 14

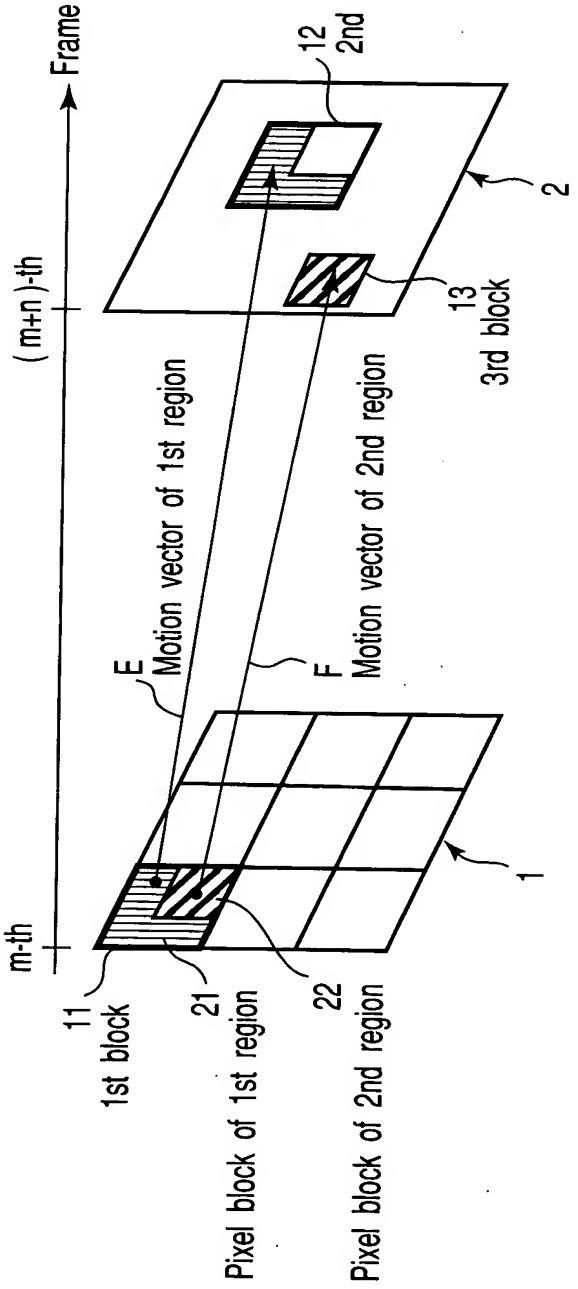

Frame
(m+n)-th
m-th
12
2nd block
2
13
3rd block
E
Motion vector of 1st region
F
Motion vector of 2nd region
1
11
1st block
21
Pixel block of 1st region
22
Pixel block of 2nd region

FIG. 15

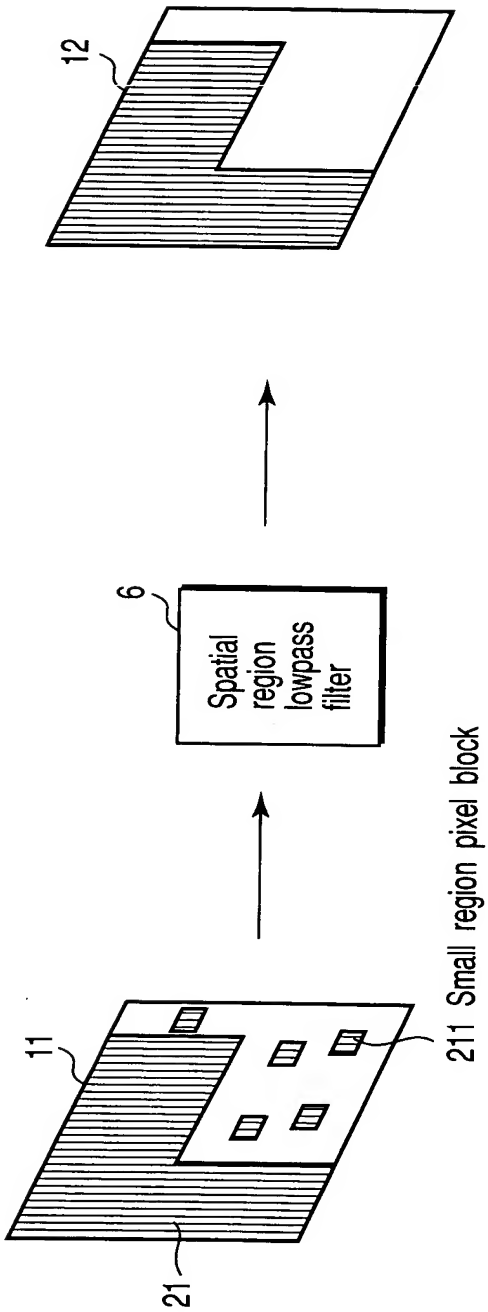

12
6
Spatial region lowpass filter
11
211 Small region pixel block
21

FIG. 19

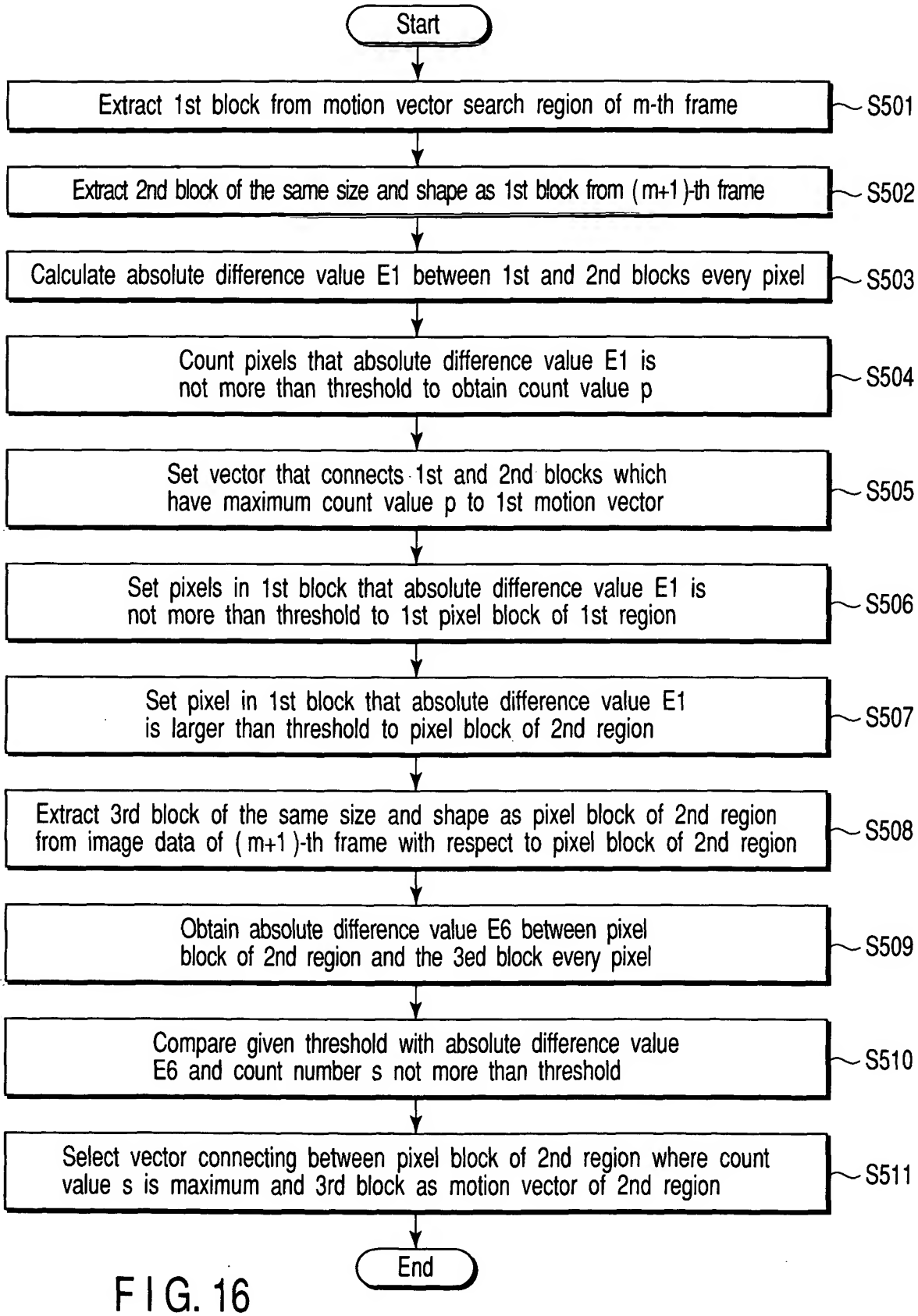

Start
Extract 1st block from motion vector search region of m-th frame
S501
Extract 2nd block of the same size and shape as 1st block from (m+1)-th frame
S502
Calculate absolute difference value E1 between 1st and 2nd blocks every pixel
S503
Count pixels that absolute difference value E1 is not more than threshold to obtain count value p
S504
Set vector that connects 1st and 2nd blocks which have maximum count value p to 1st motion vector
S505
Set pixels in 1st block that absolute difference value E1 is not more than threshold to 1st pixel block of 1st region
S506
Set pixel in 1st block that absolute difference value E1 is larger than threshold to pixel block of 2nd region
S507
Extract 3rd block of the same size and shape as pixel block of 2nd region from image data of (m+1)-th frame with respect to pixel block of 2nd region
S508
Obtain absolute difference value E6 between pixel block of 2nd region and the 3ed block every pixel
S509
Compare given threshold with absolute difference value E6 and count number s not more than threshold
S510
Select vector connecting between pixel block of 2nd region where count value s is maximum and 3rd block as motion vector of 2nd region
S511
End

FIG. 16

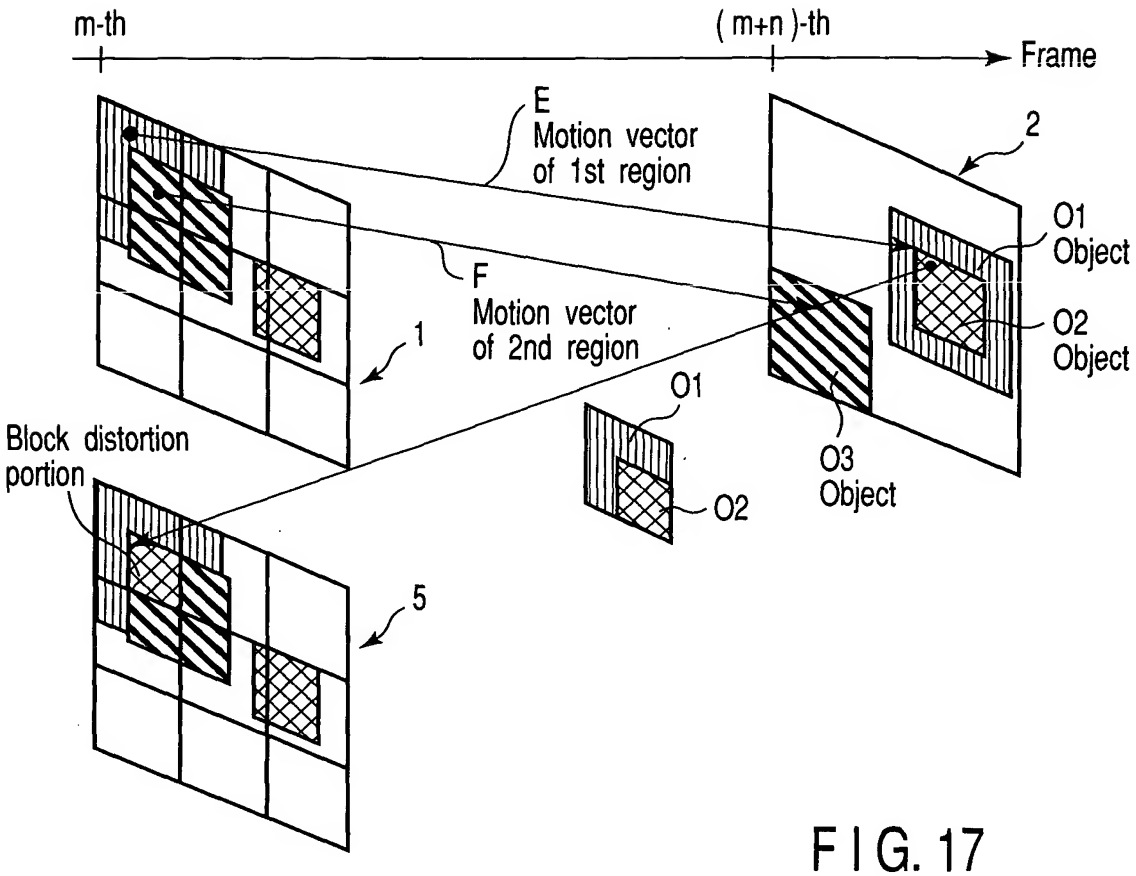

m-th
(m+n)-th
Frame
E
Motion vector
of 1st region
2
O1
Object
F
Motion vector
of 2nd region
O2
Object
1
O1
Block distortion
portion
O3
Object
O2
5

FIG. 17

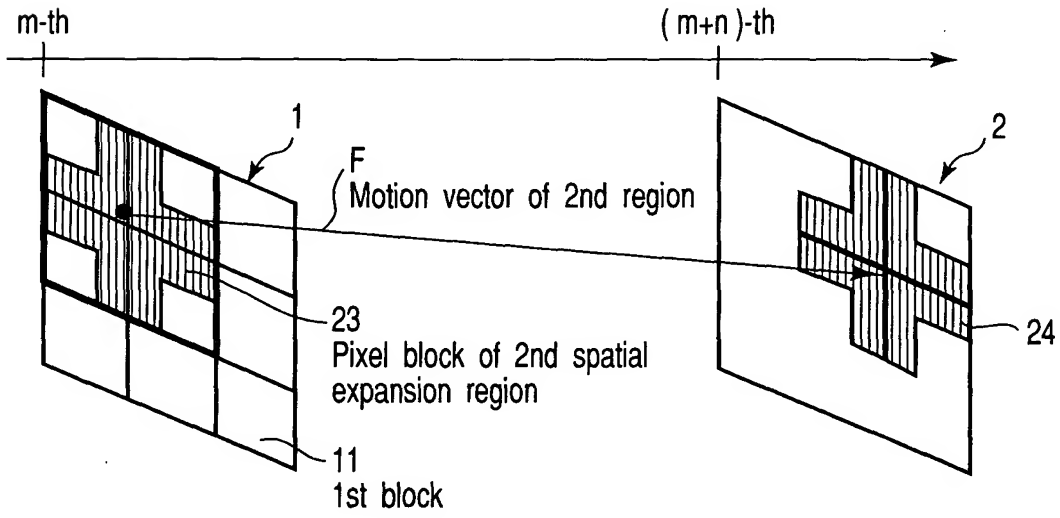

m-th
(m+n)-th
1
2
F
Motion vector of 2nd region
23
Pixel block of 2nd spatial
expansion region
24
11
1st block

FIG. 21

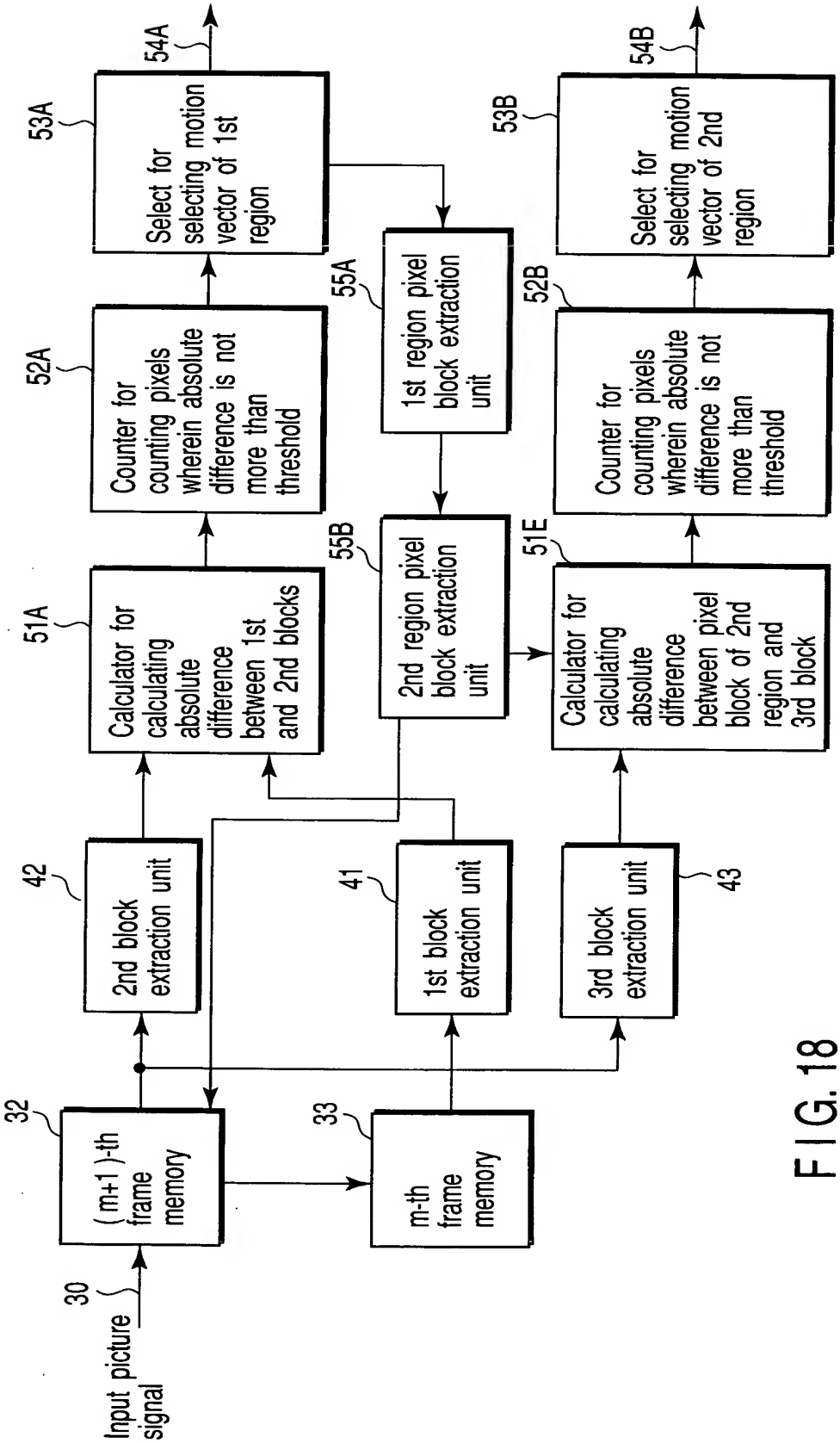

Input picture signal
30
(m+1)-th frame memory
32
m-th frame memory
33
2nd block extraction unit
42
1st block extraction unit
41
3rd block extraction unit
43
Calculator for calculating absolute difference between 1st and 2nd blocks
51A
2nd region pixel block extraction unit
55B
Calculator for calculating absolute difference between pixel block of 2nd region and 3rd block
51E
Counter for counting pixels wherein absolute difference is not more than threshold
52A
1st region pixel block extraction unit
55A
Counter for counting pixels wherein absolute difference is not more than threshold
52B
Select for selecting motion vector of 1st region
53A
54A
Select for selecting motion vector of 2nd region
53B
54B

FIG. 18

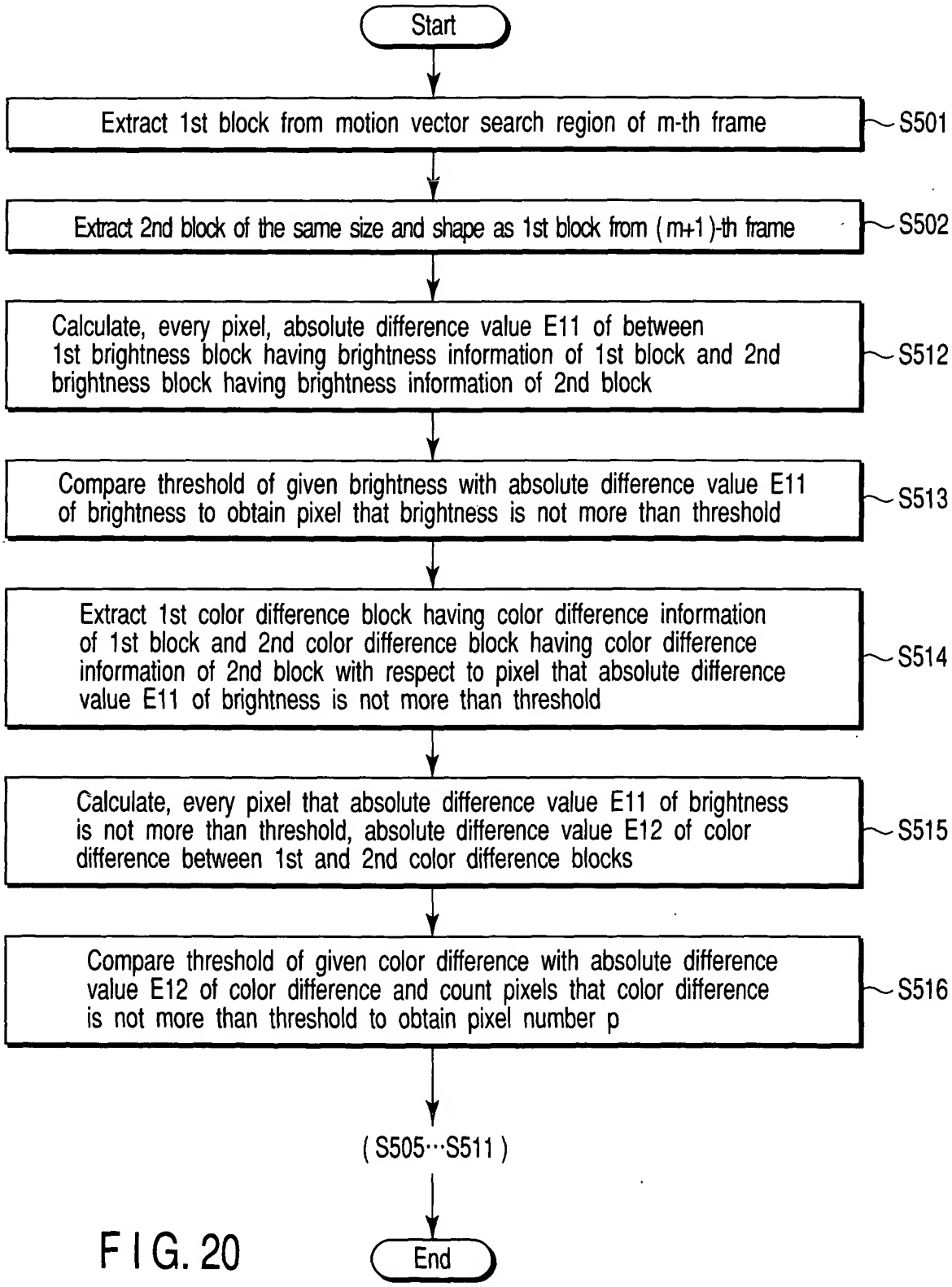

Start
Extract 1st block from motion vector search region of m-th frame
S501
Extract 2nd block of the same size and shape as 1st block from (m+1)-th frame
S502
Calculate, every pixel, absolute difference value E11 of between 1st brightness block having brightness information of 1st block and 2nd brightness block having brightness information of 2nd block
S512
Compare threshold of given brightness with absolute difference value E11 of brightness to obtain pixel that brightness is not more than threshold
S513
Extract 1st color difference block having color difference information of 1st block and 2nd color difference block having color difference information of 2nd block with respect to pixel that absolute difference value E11 of brightness is not more than threshold
S514
Calculate, every pixel that absolute difference value E11 of brightness is not more than threshold, absolute difference value E12 of color difference between 1st and 2nd color difference blocks
S515
Compare threshold of given color difference with absolute difference value E12 of color difference and count pixels that color difference is not more than threshold to obtain pixel number p
S516
(S505···S511)
End

FIG. 20

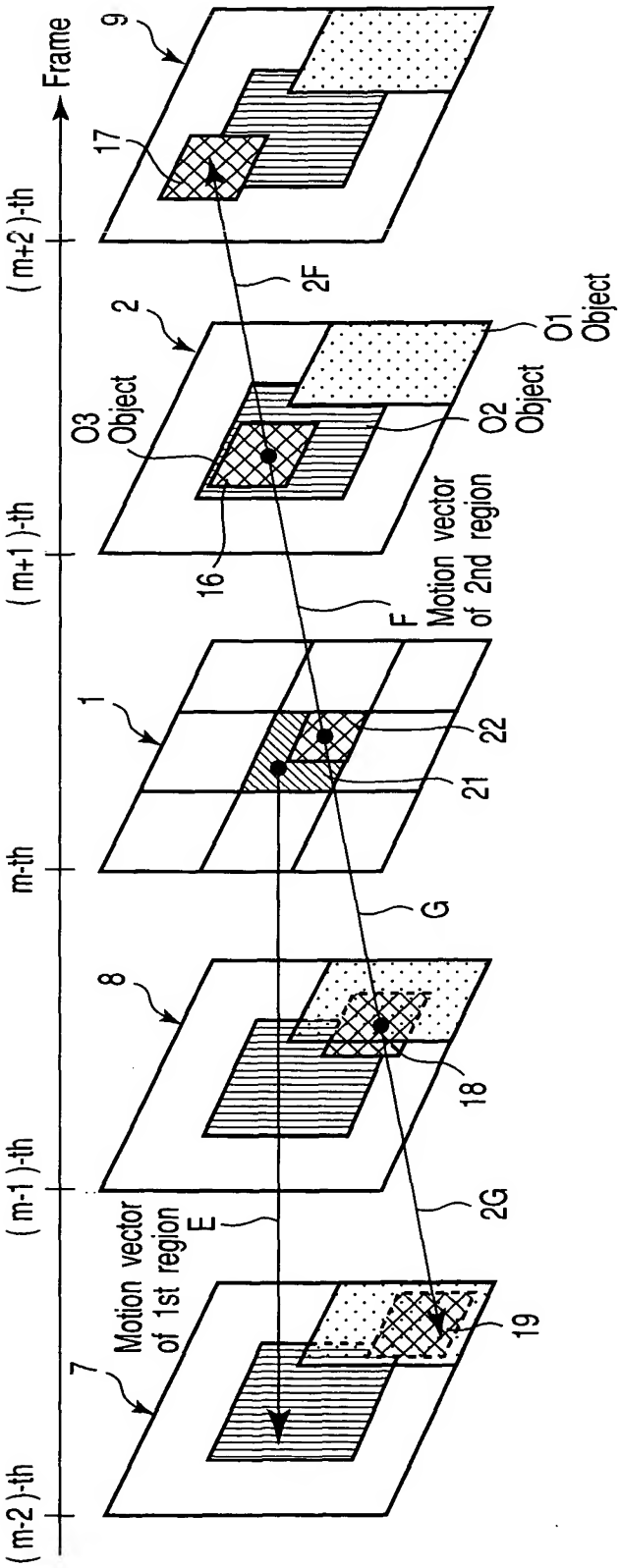

Frame
(m+2)-th
(m+1)-th
m-th
(m-1)-th
(m-2)-th
9
17
2F
2
O1 Object
O3 Object
O2 Object
16
F
Motion vector of 2nd region
1
22
21
G
8
18
2G
E
Motion vector of 1st region
7
19

FIG. 22

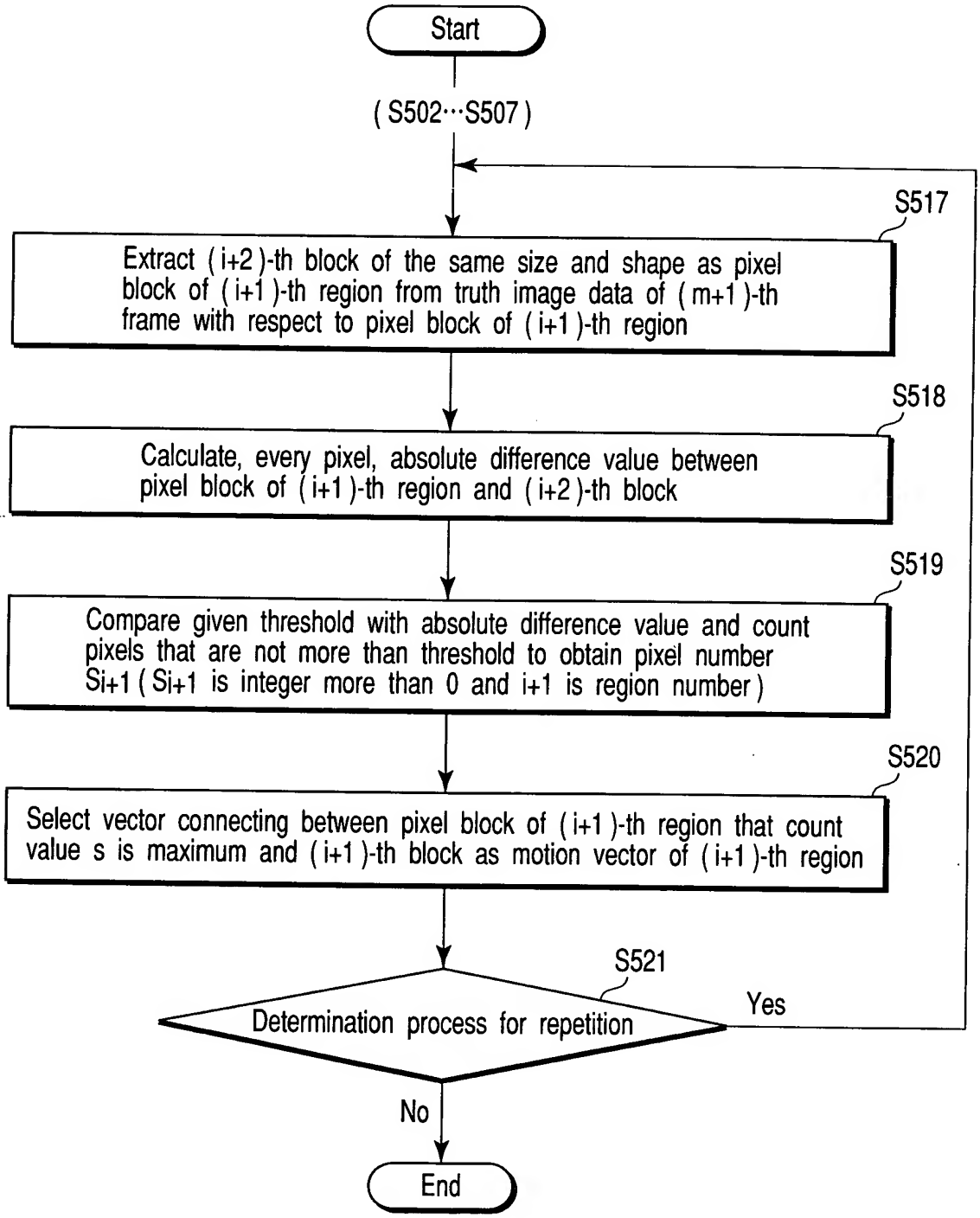

Start
(S502···S507)
S517
Extract (i+2)-th block of the same size and shape as pixel block of (i+1)-th region from truth image data of (m+1)-th frame with respect to pixel block of (i+1)-th region
S518
Calculate, every pixel, absolute difference value between pixel block of (i+1)-th region and (i+2)-th block
S519
Compare given threshold with absolute difference value and count pixels that are not more than threshold to obtain pixel number Si+1 (Si+1 is integer more than 0 and i+1 is region number)
S520
Select vector connecting between pixel block of (i+1)-th region that count value s is maximum and (i+1)-th block as motion vector of (i+1)-th region
S521
Determination process for repetition
Yes
No
End

FIG. 23

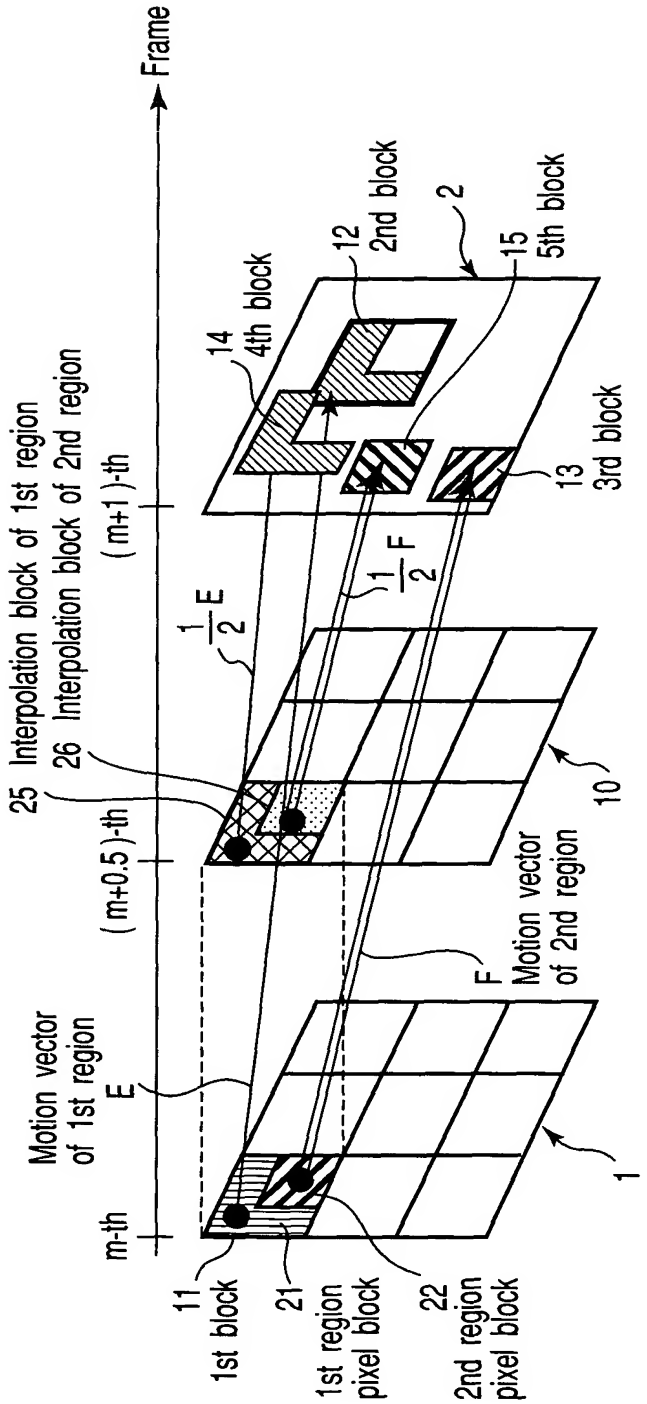

Frame
Interpolation block of 1st region
Interpolation block of 2nd region
(m+1)-th
(m+0.5)-th
m-th
Motion vector of 1st region
E
Motion vector of 2nd region
F
1/2 E
1/2 F
11 1st block
21 1st region pixel block
22 2nd region pixel block
12 2nd block
13 3rd block
14 4th block
15 5th block
1
2
10
25
26

FIG. 24

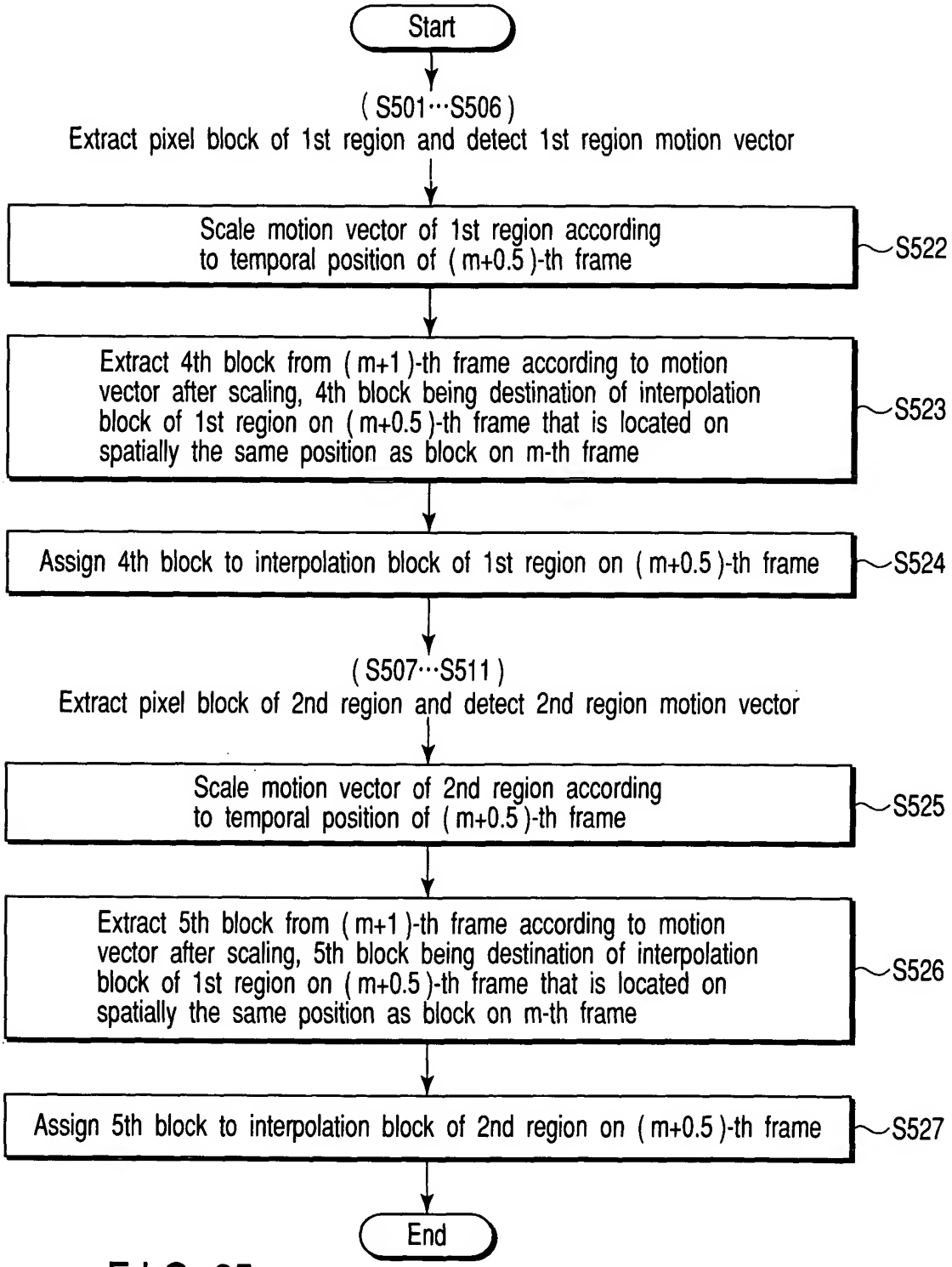

Start
(S501···S506)
Extract pixel block of 1st region and detect 1st region motion vector
Scale motion vector of 1st region according to temporal position of (m+0.5)-th frame
S522
Extract 4th block from (m+1)-th frame according to motion vector after scaling, 4th block being destination of interpolation block of 1st region on (m+0.5)-th frame that is located on spatially the same position as block on m-th frame
S523
Assign 4th block to interpolation block of 1st region on (m+0.5)-th frame
S524
(S507···S511)
Extract pixel block of 2nd region and detect 2nd region motion vector
Scale motion vector of 2nd region according to temporal position of (m+0.5)-th frame
S525
Extract 5th block from (m+1)-th frame according to motion vector after scaling, 5th block being destination of interpolation block of 1st region on (m+0.5)-th frame that is located on spatially the same position as block on m-th frame
S526
Assign 5th block to interpolation block of 2nd region on (m+0.5)-th frame
S527
End

FIG. 25

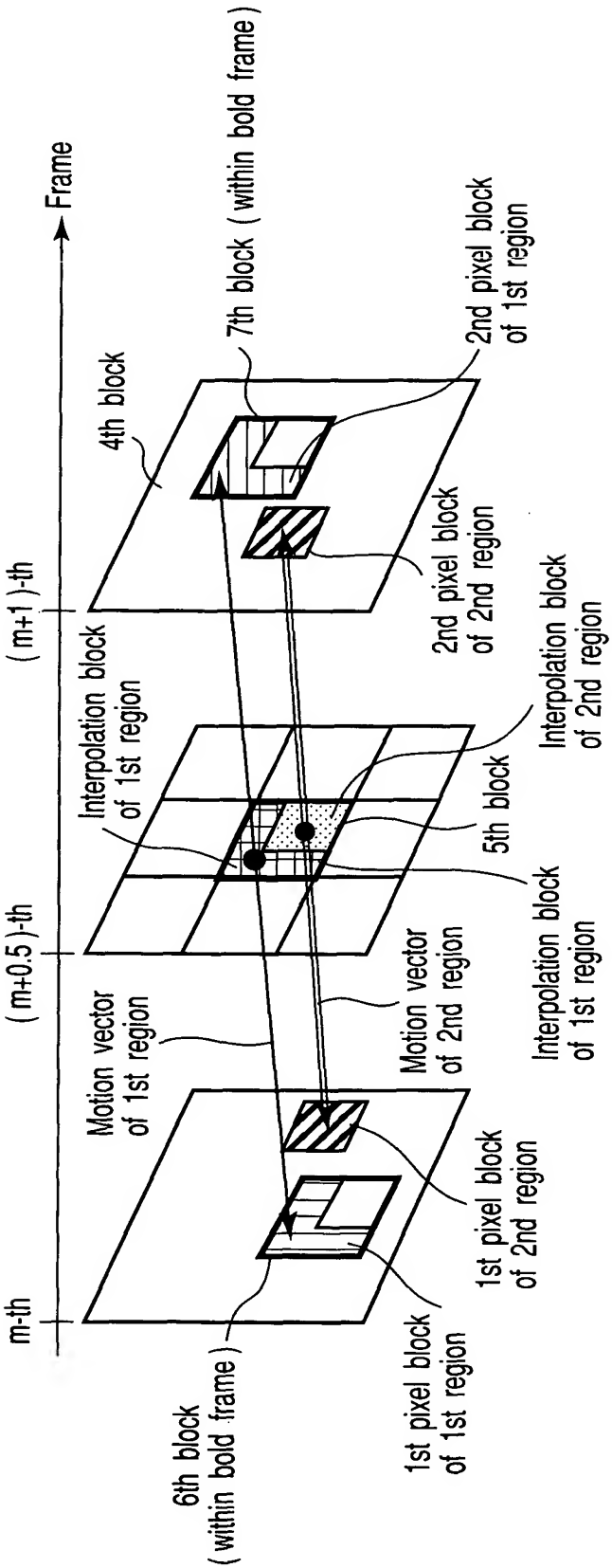

Frame
(m+1)-th
(m+0.5)-th
m-th
4th block
7th block (within bold frame)
2nd pixel block of 1st region
2nd pixel block of 2nd region
Interpolation block of 1st region
Interpolation block of 2nd region
5th block
Motion vector of 1st region
Motion vector of 2nd region
Interpolation block of 1st region
1st pixel block of 2nd region
1st pixel block of 1st region
6th block (within bold frame)

FIG. 26

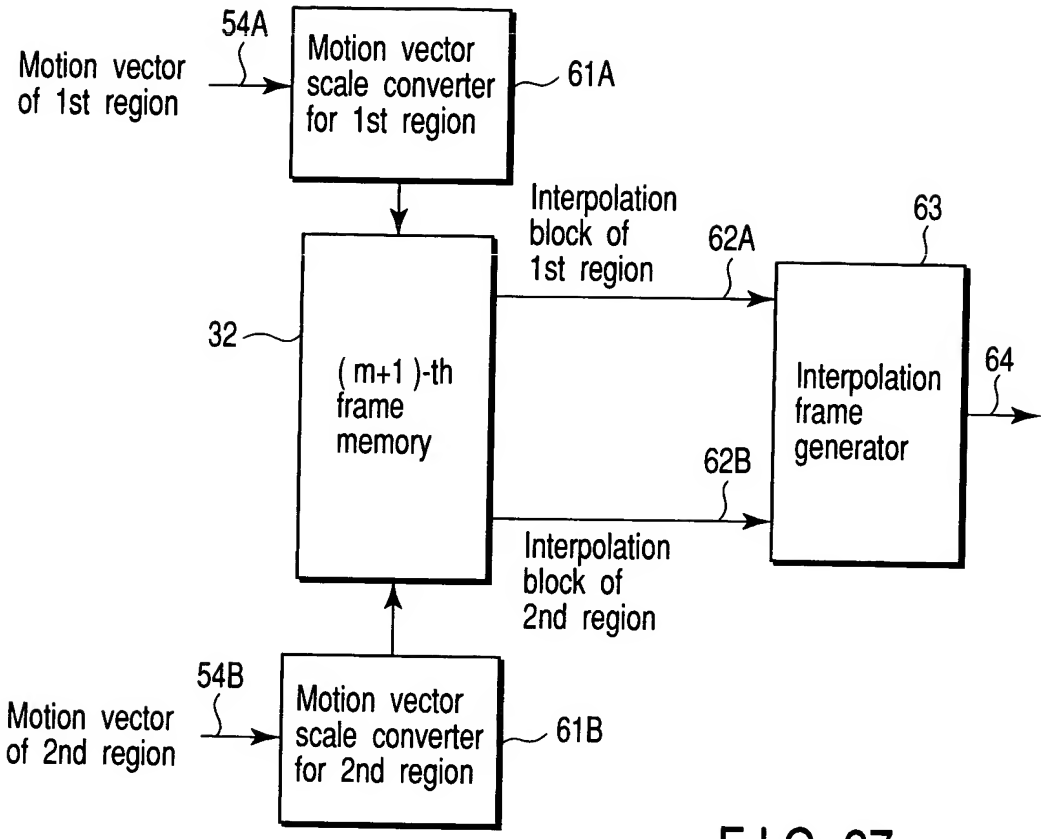

54A
Motion vector of 1st region
Motion vector scale converter for 1st region
61A
Interpolation block of 1st region
62A
63
32
(m+1)-th frame memory
Interpolation frame generator
64
62B
Interpolation block of 2nd region
54B
Motion vector of 2nd region
Motion vector scale converter for 2nd region
61B

FIG. 27

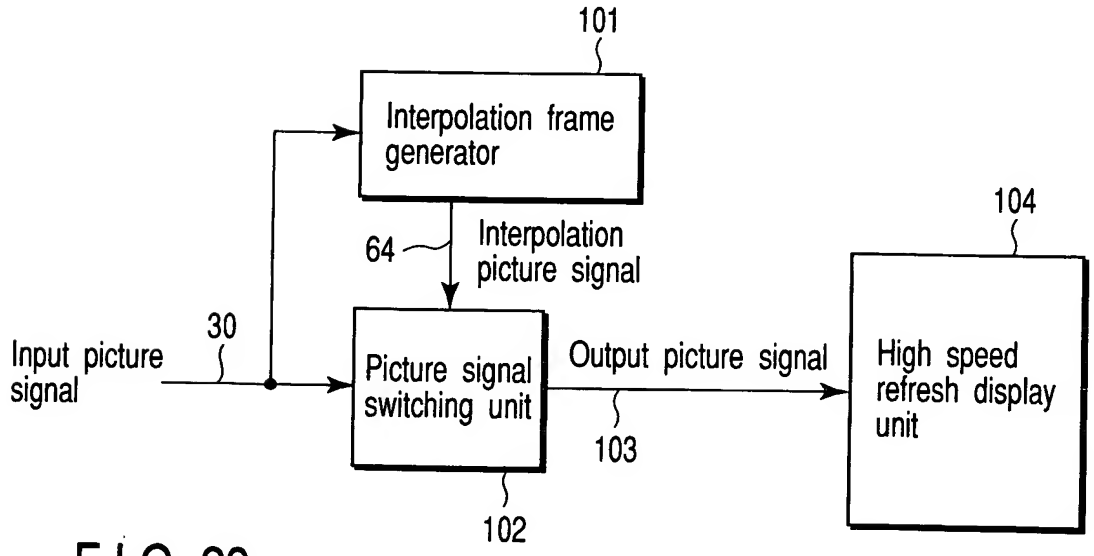

101
Interpolation frame generator
64
Interpolation picture signal
104
30
Input picture signal
Picture signal switching unit
Output picture signal
High speed refresh display unit
103
102

FIG. 29

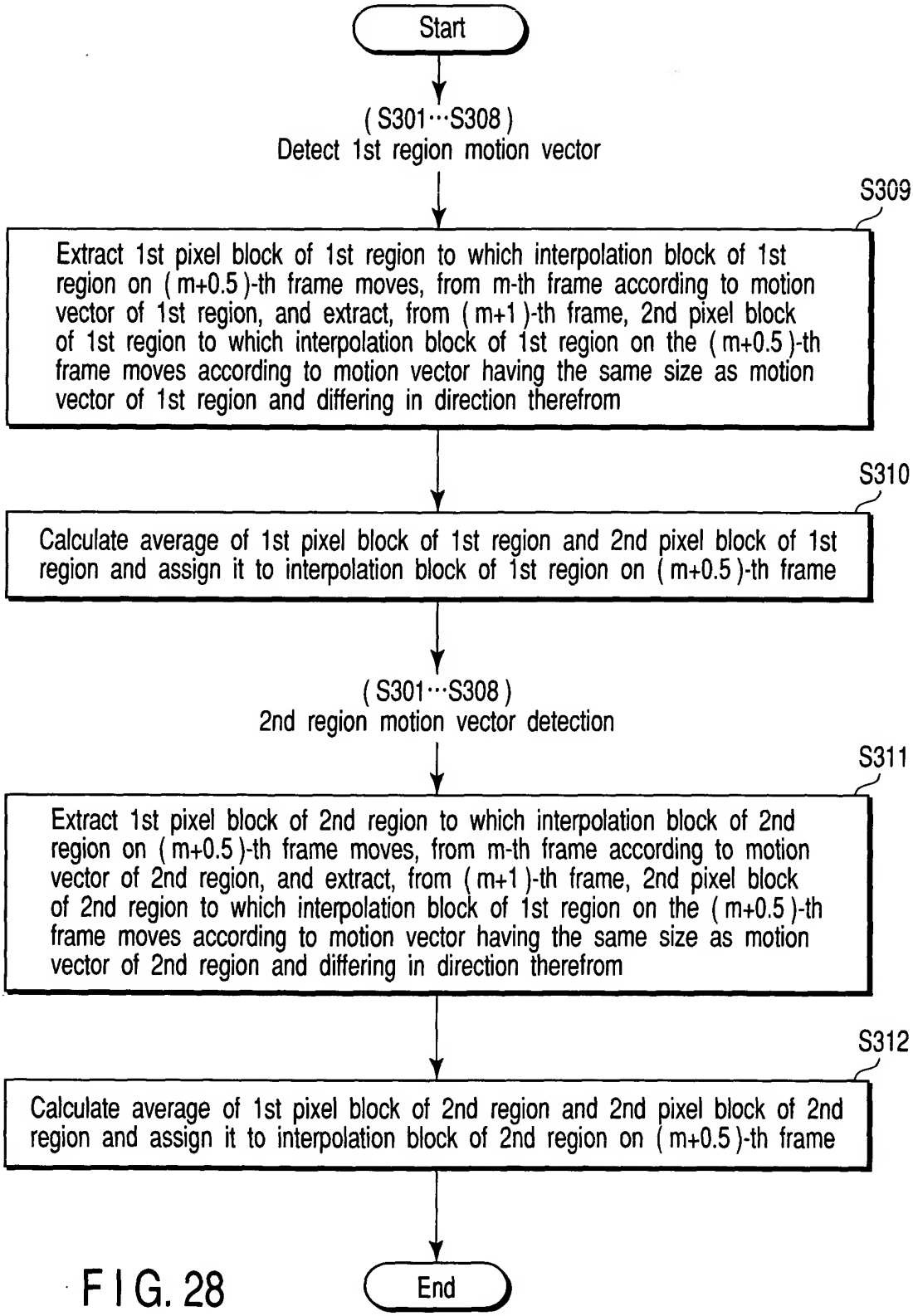

Start
(S301···S308)
Detect 1st region motion vector
S309
Extract 1st pixel block of 1st region to which interpolation block of 1st region on (m+0.5)-th frame moves, from m-th frame according to motion vector of 1st region, and extract, from (m+1)-th frame, 2nd pixel block of 1st region to which interpolation block of 1st region on the (m+0.5)-th frame moves according to motion vector having the same size as motion vector of 1st region and differing in direction therefrom
S310
Calculate average of 1st pixel block of 1st region and 2nd pixel block of 1st region and assign it to interpolation block of 1st region on (m+0.5)-th frame
(S301···S308)
2nd region motion vector detection
S311
Extract 1st pixel block of 2nd region to which interpolation block of 2nd region on (m+0.5)-th frame moves, from m-th frame according to motion vector of 2nd region, and extract, from (m+1)-th frame, 2nd pixel block of 2nd region to which interpolation block of 1st region on the (m+0.5)-th frame moves according to motion vector having the same size as motion vector of 2nd region and differing in direction therefrom
S312
Calculate average of 1st pixel block of 2nd region and 2nd pixel block of 2nd region and assign it to interpolation block of 2nd region on (m+0.5)-th frame
End

FIG. 28

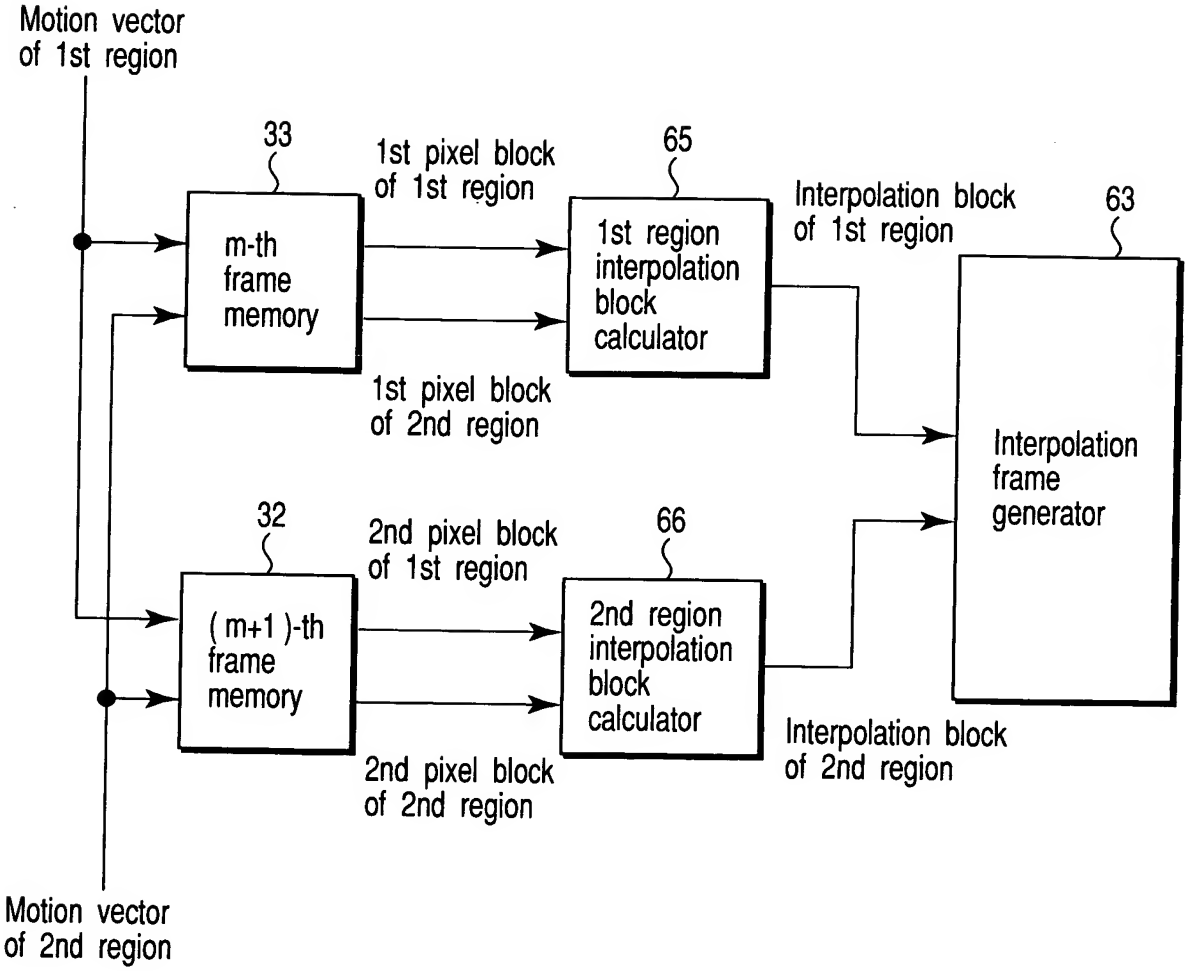

Motion vector of 1st region
33
1st pixel block of 1st region
65
Interpolation block of 1st region
63
m-th frame memory
1st region interpolation block calculator
1st pixel block of 2nd region
Interpolation frame generator
32
2nd pixel block of 1st region
66
(m+1)-th frame memory
2nd region interpolation block calculator
Interpolation block of 2nd region
2nd pixel block of 2nd region
Motion vector of 2nd region

FIG. 30